§20. Characteristics of High -Te Plasmas Related to NBI-Beam-Driven Current

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In the Large Helical Device (LHD), operation at high electron temperature (> 10 keV) and ITB formation have been achieved using high power ECH (> 2 MW) and strongly focused mirror antennas. In the experiments, neutral-beam-driven currents modify the profiles of the rotational transform $\iota/2\pi$, and two different kinds of improved confinement were observed. Using the heat pulse propagation techniques generated by modulated ECH (MECH), we investigated the electron heat transport to elucidate the triggering mechanisms for the improved confinement. and found the difference of heat transport by the direction of the beam-driven current 1).

The ITB formation was only observed in counter injected NBI plasmas with centrally focused ECH. There are two questions: (1) What happens when the magnetic field is reversed? (2) How does the amount of beam-driven current affect the characteristics of ITB formation?

We have three tangential NBI injectors, two counter (BL1,3) and one co (BL2) injection NBI in the normal magnetic configuration. In order to make clear the effect of the plasma current direction on ITB formation (Question (1)), we made the same experiments in the NBI plasmas with reversed magnetic configuration.

The target plasmas were NBI-sustained low density plasmas with $\overline{n}_e = 0.5 \times 10^{19}\mathrm{m}^{-3}$ and $\mathrm{T}_{e0} \sim 1.5 - 2.0$ keV. The magnetic axis was placed on R=3.5 m, and the field strength was -2.829 T on the axis, where the minus sign means reversed field compared with the normal magnetic configuration.

Figure 1 shows the electron temperature profiles measured by Thomson scattering for a) counter (BL2) and b) co (BL3) injected NBI target plasmas, respectively, at the timings of just before ECH on and ECH off. In this case, BL2 injector drove counter current and BL3 drove co current. There was a narrow peaked T_e profile with steep temperature gradient in the only counter-NBI (BL2) plasma. On the other hand, wide high Te profile appeared in co-NBI (BL3) sustained plasma. The T_e profile was obviously different from each other before ECH injection. The flattened profile was observed for counter-NBI and the peaked profile for co-NBI plasmas, which is the same feature as in the normal magnetic configuration.

This results assures the fact that the behavior of T_e profiles were affected by the beam driven current , i.e. he profiles of the rotational transform $\iota/2\pi$, not by NBI power deposition profiles.

In order to answer the question (2), we tried ECH injection into the long pulse counter-NBI (5sec. dureation) plasma that had a gradual counter current increase from 0 to 22kA. ECH injection timing was changed shot by shot to investigate the effect of current amount on the ITB formation. However, we could not find big dependence on the total current within this current range. This suggests the current profile is more important than the total amount. Deeper investigation on the current profile is required to make the phenomena clear.

References

1) T. Shimozuma, et al., 20th IAEA Fusion Energy Conference, 1-6 November 2004, Vilamoura, Portugal, EX/P3-12.

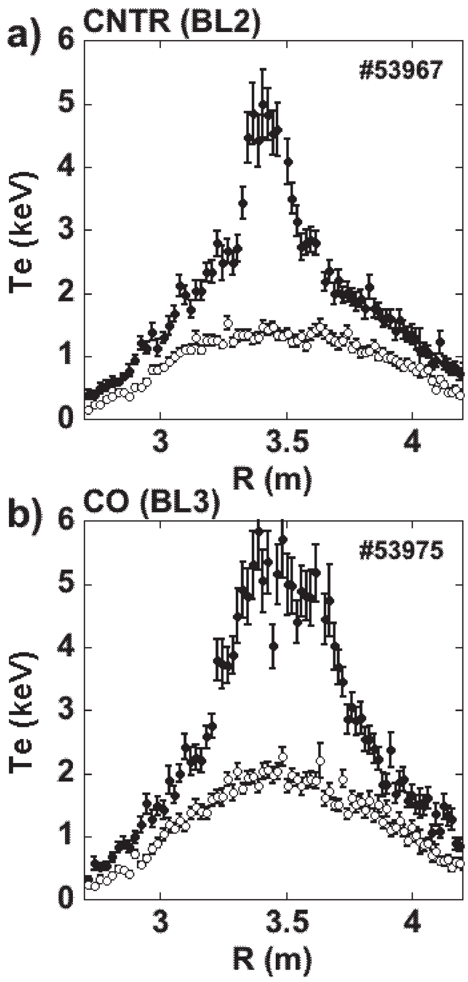

Fig. 1: Electron temperature profiles just before ECH on and off a) for counter-NBI (BL2) and b) for co-NBI (BL3) sustained plasmas.